ZOOLOGY

# EFFECT OF SAPROPHAGES ON DYNAMICS OF THE MASS OF ASH ELEMENTS IN FOREST LITTER DURING ITS DECOMPOSITION

A. D. Pokarzhevskii

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In the decomposition of plant residue, there is not only an increase in relative content of elements, but also in the mass of ash substances [1, 2] because of their influx from without and their inclusion in the litter. This is the result of both physicochemical [3] and microbial fixation [4]. The use of insecticides leads to slowing down of the process of segregating elements from the plant litter in comparison with the control [5, 6], evidently as a result of eliminating saprophages from the process of decomposition. In oak woods of the steppe forests saprophages occupy a leading position in the decomposition processes of the leaf litter [7, 8], and their exclusion must have a substantial effect on the dynamics of the mass of ash elements in the litter.

Experiments were carried out in the V. V. Alekhin Central Chernozem Preserve (Kushaya Province). A description of the forest plots was given by G. F. Kurcheva [7]. Leaves of the oak, lying under the snow through the winter (preliminarily cleansed of mechanical admixtures) were placed into small sacks 0.04 m$^2$ in area, made of caprone net (interstices, 8 mm), or of screen (interstices, 0.8 mm). In mass, the batch equalled the amount of annual leaf fall for the given area (0.04 m$^2$). The screen protected the litter from large soil

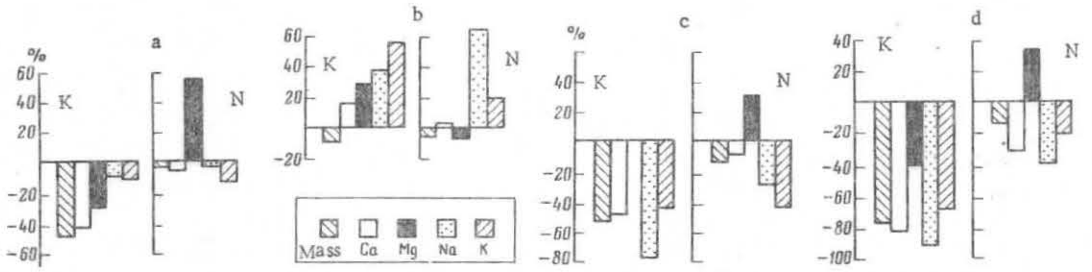


Fig. 1. Change in mass of ash elements in autumn oak litter (% of initial amount). N) without animals; K) control; a) 1974, mesh sacks; b) 1974, screen sacks; c) 1975, September; d) 1975, October.

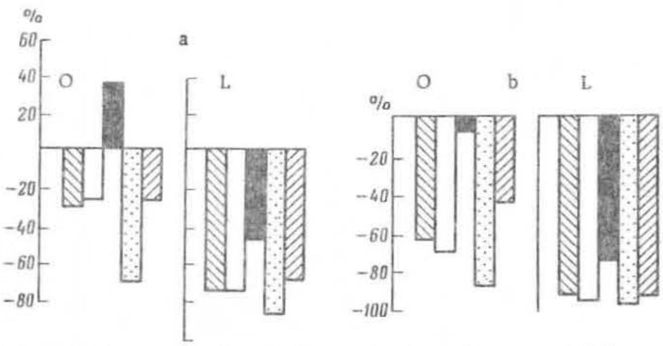


Fig. 2. Change in mass of ash elements in autumn oak litter with participation of bibionid larvae (% of initial amount). O) without larvae; L) with larvae. a) 1975, September; b) 1975, October.

A. N. Severtsov Institute of Evolutionary Morphology and Ecology of Animals, Academy of Sciences of the USSR, Moscow. (Presented by Academician M. S. Gilyarov, August 23, 1978.) Translated from Doklady Akademii Nauk SSSR, Vol. 245, No. 1, pp. 265-268, March 1979. Original article submitted October 30, 1978.

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TABLE 1. Concentration of the Elements Studied in Autumn Oak Leaf Litter (mg/g dry weight) in Different Variants of the Equipment

| Variant | No. of sample | Ash, % | Calcium | Magnesium | Potassium | Sodium |
|---|---|---|---|---|---|---|
| 1974, May, initial | 3 | 8,6 ± 0,2 | 17,10 ± 0,48 | 1,57 ± 0,35 | 1,07 ± 0,05 | 0,335 ± 0,072 |
| September, control | | | | | | |
| mesh | 10 | 17,4 ± 1,5 | 18,47 ± 0,83 | 1,90 ± 0,26 | 1,71 ± 0,15 | 0,556 ± 0,029 |
| screen | 6 | 18,7 ± 2,8 | 23,87 ± 2,69 | 2,42 ± 0,31 | 2,18 ± 0,44 | 0,536 ± 0,053 |
| Without animals* | | | | | | |
| mesh | 10 | 11,1 ± 0,4 | 17,01 ± 0,55 | 2,53 ± 0,28 | 0,97 ± 0,11 | 0,341 ± 0,025 |
| screen | 6 | 11,1 ± 0,5 | 17,69 ± 0,68 | 1,54 ± 0,07 | 1,32 ± 0,32 | 0,572 ± 0,023 |
| September, fresh fall | 8 | 6,8 ± 0,2 | 16,27 ± 0,90 | 2,02 ± 0,08 | 6,74 ± 0,71 | 0,389 ± 0,023 |
| 1975, May, initial | 6 | 9,5 ± 1,1 | 21,34 ± 0,36 | 1,84 ± 0,29 | 0,96 ± 0,20 | 1,230 ± 0,050 |
| September, control | 7 | 14,0 ± 0,4 | 22,87 ± 0,29 | 3,83 ± 0,39 | 1,15 ± 0,18 | 0,649 ± 0,057 |
| Without animals* | 8 | 11,1 ± 0,3 | 22,33 ± 0,56 | 2,75 ± 0,32 | 0,66 ± 0,17 | 1,020 ± 0,270 |
| October, control | 8 | 12,9 ± 0,4 | 19,16 ± 0,70 | 5,23 ± 0,49 | 1,14 ± 0,17 | 0,612 ± 0,072 |
| Without animals* | 7 | 11,6 ± 0,7 | 21,09 ± 0,92 | 2,88 ± 0,30 | 0,88 ± 0,11 | 0,872 ± 0,128 |

*With naphthalene treatment

TABLE 2. Decomposition of Oak Litter and Mass of Mineral Elements in It*

| Variant | Dry weight, g | Calcium, mg | Magnesium, mg | Sodium, mg | Potassium, mg |
|---|---|---|---|---|---|
| May 27, 1974, initial mass | 14,13 | 242,6 ± 6,1 | 22,3 ± 5,0 | 4,74 ± 1,02 | 15,13 ± 0,65 |
| September 18, remaining mass, mesh, control | 8,15 ± 0,96 | 144,9 ± 15,5 | 16,2 ± 2,4 | 4,46 ± 0,46 | 13,91 ± 2,20 |
| Without animals | 13,77 ± 0,05 | 234,0 ± 7,6 | 34,8 ± 3,9 | 4,70 ± 0,35 | 13,38 ± 1,47 |
| Screen, control | 13,02 ± 0,24 | 287,0 ± 12,2 | 29,0 ± 2,7 | 6,61 ± 0,83 | 23,85 ± 1,86 |
| Without animals | 13,69 ± 0,10 | 245,0 ± 8,4 | 21,1 ± 0,9 | 7,82 ± 0,26 | 18,18 ± 4,41 |
| May 17, 1975, initial mass | 14,94 | 319,2 ± 5,2 | 27,5 ± 4,3 | 18,60 ± 0,72 | 14,33 ± 2,96 |
| September 13, remaining mass, control | 7,33 ± 1,42 | 167,9 ± 33,0 | 27,6 ± 5,2 | 4,40 ± 0,68 | 8,10 ± 1,72 |
| Without animals | 13,19 ± 0,14 | 295,3 ± 7,0 | 36,2 ± 4,0 | 13,52 ± 1,56 | 8,60 ± 1,02 |
| October 6, control | 3,63 ± 0,79 | 68,5 ± 14,8 | 17,7 ± 3,4 | 1,85 ± 0,51 | 4,81 ± 1,44 |
| Without animals | 13,0 ± 0,24 | 274,0 ± 12,6 | 37,5 ± 3,9 | 11,28 ± 1,65 | 11,42 ± 1,38 |

*For number of samples see Table 1.

animals. Thirty-two sacks, eight per plot, were placed on the surface of the soil. Two plots were controls, and two were sprinkled with naphthalene to keep invertebrates from the litter (a method suggested by M. S. Gilyarov in 1941). The naphthalene dose was 300 $g/m^2$. As the naphthalene evaporated, more was added. A test of the effect of naphthalene on content of elements investigated gave negative results. In 1974, 20 mesh sacks were placed without preventing access to them of invertebrates, and 12 sacks of screening; these were out for 115 days (May–September). In 1975 only mesh sacks were used, in both variants half being out for 119 days (May–September) and the rest, 142 days (May–October). The litter left after the experiment was cleansed of soil particles, dried at 105°C, and weighed. The degree of decomposition was judged by loss of weight. Calcium, magnesium, sodium, and potassium content was determined for the litter at the beginning and after decomposition as well as in fresh litter collected in September, 1974. Samples were incinerated in a muffled burner at 400° for 6 h, and content of calcium and magnesium was determined in a hydrochloric acid solution of the ash using the Trilonometric method, and potassium and sodium, by the flame-photometric method.

TABLE 3. Effect of Bibionids on Decomposition of Litter and Loss of Elements from It

| Variant | No. of samples | Dry mass, g | Calcium, mg | Magnesium mg | Sodium, mg | Potassium, mg |
|---|---|---|---|---|---|---|
| May 17, initial mass | 6 | 14,94 | 319,2 ± 5,2 | 27,50 ± 4,30 | 18,60 ± 0,72 | 14,33 ± 2,96 |
| September 13, remaining mass | | | | | | |
| without larvae | 4 | 10,58 ± 1,15 | 229,6 ± 77,5 | 36,95 ± 6,05 | 5,50 ± 0,36 | 10,44 ± 2,14 |
| with larvae (300 individuals) | 3 | 4,06 ± 0,78 | 85,7 ± 21,2 | 15,23 ± 4,34 | 2,94 ± 0,79 | 4,98 ± 2,37 |
| 6 X | | | | | | |
| without larvae | 4 | 6,08 ± 0,72 | 106,7 ± 13,9 | 26,46 ± 2,57 | 2,60 ± 0,87 | 8,33 ± 1,75 |
| with larvae | 4 | 1,63 ± 0,19 | 30,3 ± 4,9 | 8,86 ± 2,20 | 1,09 ± 0,12 | 1,30 ± 0,33 |

The content of the elements investigated was higher in the decomposed litter than in the initial mass, and in the variants with animals, the concentration of the elements was somewhat higher than in that without animals. In the litter that overwintered, the concentration of calcium dropped sharply, which is evidence of its being leached out by melt waters (during the winter only 4% of the litter decomposes [7]). The concentration of calcium and sodium in the litter increased, but magnesium remained largely at the same level as in the fresh litter (Table 1).

The dynamics of mass of the ash elements in leaf litter in the process of decomposition in different years and in different variants differs noticeably (Table 2, Fig. 1). When decomposition takes place in the absence of all groups of soil fauna, there is a fixation of ash elements in the litter. When microorganisms and small soil animals take part in the decomposition, the elements remain in the litter to a greater degree than when only microbial decomposition takes place. Participation of large saprophages promotes the release of mineral substances from plant residue. This is particularly evident in the action of such a powerful agent of decomposition as the larvae of bibionids (Table 3, Fig. 2), the numbers of which in 1975 attained 1 nest per $m^2$ (a nest contained an average of 300 larvae).

Atmospheric precipitation is another source of elements added to the decomposing litter; during the summer months after washing the tree crowns it contained 1.8 $g/m^2$ of calcium and 1.2 $g/m^2$ of magnesium [9].

Increase in ash content and concentration of elements is coupled with mineralization of the litter and fixing in it of mineral substances. In this case, deposition on the surface of the litter of excrement by animals which contains large concentrations of elements in comparison with the original food, promotes the enrichment of the litter with ash substances. When the excrement is washed in, chemical elements are fixed, and this is reflected in their greater concentration in the litter which decomposed in the presence of soil animals.

In decomposition of plant residue by microorganisms alone, the amount of washing out of elements from the residue is lower than the amount fixed in the residue as a result of which the total mass of elements is increased.

Small soil animals in the process of life activity perforate the litter, increasing the decomposing surface and promoting the development of microflora. Probably for this reason, the retention of the elements studied when small animals and microorganisms are active in the litter is higher than when only microorganisms participate in the

Large saprophages, intensively digesting the litter, extract elements from it, and counteract the process of their being fixed in the litter, thus promoting the return of mineral substances into the soil. Excluding soil animals from the process of decomposition leads to a deceleration of the mineral element cycle of plant nutrition.

Such a situation may arise with the irrational application of pesticides, industrial contamination, and other forms of anthropogenic action on the environment. For this reason, in evaluating the negative results of such a type of disturbance of the environment, it is necessary to consider the role of soil animals in the processes of decomposition of organic substances and the biological cycle of elements.

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